Donald Thomas
Hawaii Institute of Geophysics and Planetology
University of Hawaii

Perspective on the Trajectory of AOC Discussions up to the Present Time

I'll offer my comments in two parts: in the first, I will comment on where the current process has not been optimally productive; in the second, I'll summarize the hydrogeology questions that I believe need to be answered in order to have a defensible risk assessment.

I. Past Interaction with AECOM/GSI

The pattern of presentations in the face-to-face meetings has been to: 1) outline one or more work tasks that are proposed and being pursued; 2) a presentation of a summary of the data acquired from those tasks that have been completed; and 3) a set of assertions are made as to what the data are showing. When questions are raised about those assertions, they are noted, but, in subsequent meetings, there is little time made available, or effort made, to provide a full accounting of how the assertions were arrived at or to address any contrary data that don't support the assertions. Stated very briefly we are being presented with: "This is our theory of the conceptual site model, and these are the data that support that model… the end."

Salient examples of this practice are:
The proposed geologic conceptual site model was, allegedly, developed on the basis of the well core data and the barrel logs, with very large, contiguous zones of a'a/clinker and pahoehoe stratigraphic layers extending thousands of feet laterally and many tens of feet vertically. We know that these lava flow types, individually, usually extend by a few tens of feet laterally and vertically, and are distributed almost randomly (at any particular elevation) across the surface of a volcano as it resurfaces itself. **We have requested documentation to support the proposed stratigraphic model repeatedly, but there has never been a detailed presentation of that data or how it was used to create the proposed model.**

The proposed groundwater flow model has shown water flow from mauka to makai in the area of Red Hill Ridge. The recent resurvey of the wellhead elevations has shown a nearly flat groundwater gradient within the monitoring wells up the ridge. **It has been repeatedly pointed out that, for that flow model to be supported, there needs to be an observable groundwater gradient in that same direction, but the model presented by AECOM remains little changed from that developed by Rotzoll and El-Kadi for the 2007 Red Hill investigation that suffered from the same weakness.**

Data have been provided to the Navy contractors on the chemical and isotopic compositions of the groundwater throughout their monitoring well network and much of Oahu. Those data show very significant variations in the ion compositions as well as the isotopic ratios in the Red Hill area that are as large as, or larger than, the entire Oahu dataset. That strongly suggest spatially disparate sources of recharge into the area of investigation and highly variable, and spatially complex, mixing of water in closely spaced wells. The Navy contractors have interpreted the data to indicate a smooth and contiguous mixing of saline and fresh water even though their cited mixing line indicates a flow path that, in no way, resembles their proposed groundwater flow directions. **We**

have repeatedly questioned this interpretation and requested that they present the underlying logic of their proposed mixing, but have not received a satisfactory answer while they still propound their original interpretation.

In the recent presentation of the seismic survey work, the results of processed reflection/ refraction data were presented, along with an interpretation of those results with respect to the depth to the bottom of the alluvium and saprolite layers within the valleys. It was noteworthy that, in nearly every case, the deepest reflector was designated as the base of saprolite. The individual presenting the results on behalf of AECOM was not the subcontractor who collected the data and was clearly not qualified to answer our questions regarding: how those interpretations were arrived at; any uncertainties in the depiction of the results; or AECOM's plans to further validate the interpretation presented. **This was a first presentation of these data and interpretations; it remains to be seen if we will receive more detailed responses to those questions posed during the presentation.**

Without detailed discussions among the respective contractor and regulatory agency SMEs of:
1) what data were used;
2) what and why available data were excluded from use; and
3) the underlying logic of incorporation of the data
in the development of the proposed CSM and flow models, I don't believe that we can, or should, accept the models proposed.

II. Critical Questions that Need to be Addressed in a CSM and Flow Model

In the discussions to date, the focus has been largely operational. From the contractors: "this is the information we need to develop a CSM and a flow model and this is how we will gather it." But there is no clear definition of how the information derived from the tasks relates specifically to the objectives of the risk assessment; nor are there any metrics as to whether the requirements of the risk assessment are being credibly met. I believe that the hydrogeologic processes involved in the release and transport of the LNAPL and dissolved contaminant (which are key to the overall risk), can be parsed into a set of specific questions that need to be adequately answered by the Navy contractors in order to have a defensible risk assessment. A partial list (with additions by other SMEs to be added) of the questions relevant to contaminant transport are detailed below. I believe that these questions can provide better focus to the work being conducted ("this work task will provide these data to answer this, or these, questions") and will allow the regulators to evaluate whether that work can produce the needed answers and whether the data, once generated, has provided credible answers that can be accepted.

1) **What is the direction of LNAPL flow in the vadose zone for a range of possible release scenarios? (With respect to the latter, we, and the contractors, need to have input from the Navy on what their consultants believe is an realistic range of release scenarios in terms of locations, volumes, and rates.)**
   1a) How does the fuel interact with the stratigraphic sequence?
   1b) How much of the fuel is tied up in the solid phase?
   1c) How does the state of water saturation of the porous media affect its ability to hold up the LNAPL phase?

1d) What is the interaction of rainfall recharge with the retained fuel in the formation?
1e) How does natural attenuation affect the residual fuel held up in the formation

2) **Once the LNAPL reaches the water table where does it go (how great a threat does it pose to groundwater wells)?**
2a) How far does it spread?
2b) In what direction is spreading favored?
2c) Does the LNAPL interact with geologic structures/obstructions differently from water and, if so, how?
2d) How does pumping affect the spread of the LNAPL?

3) **As the LNAPL components dissolve into groundwater, how does that contaminant plume move (how great a threat does the dissolved contaminant plume pose to drinking water wells)?**
3a) What is the natural direction of water flow within and around the Red Hill ridge?
3b) How much of what dissolves?
3c) How, if at all, does the dissolved phase chemically interact with the stationary phase (rocks/alluvium/saprolite)?
3d) What role does natural attenuation play in removing the dissolved constituents?
3e) How does pumping affect movement of the dissolved phase?
3f) How does the dissolved phase interact with the natural obstructions (e.g. valley fill/saprolite within the water table) within the stratigraphic matrix through which the water flows?